Phase 5: Regulatory Action Selection

Final Project Report

Total Maximum Daily Load for Dissolved Oxygen in Los Osos Creek, Warden Creek, and Warden Lake Wetland, San Luis Obispo County, California

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1. INTRODUCTION

Los Osos Creek was included on California's section 303(d) list of impaired waters for dissolved oxygen. The Clean Water Act requires a Total Maximum Daily Load (TMDL) be developed to restore impaired waterbodies to their full beneficial uses. This report addresses the dissolved oxygen impairment in the Los Osos Creek and Warden Creek watersheds and discusses follow-up monitoring to ensure that beneficial uses are protected. This section presents background information on the creek's 303(d) listing, describes the watershed and summarizes this report's outline and content.

1.1. Structure of Document

The following sections are included in this TMDL report:

- Project Definition: Identifies the 303(d) listing for Los Osos Creek and summarizes available information to characterize impairments.
- Water Quality Standards: Identifies the water quality standards applicable to the listing.
- Data Review: Provides an inventory and analysis of available water quality data.
- Monitoring: Discusses follow-up monitoring to track dissolved oxygen impairments in the Warden Creek and Los Osos Creek watersheds.
- Implementation: Discusses plans for tracking the dissolved oxygen impairment.

1.2. Project Definition

Los Osos Creek was identified as impaired for dissolved oxygen on the 2002 303(d) list. Review of available water quality monitoring data from the Morro Bay National Monitoring Program (NMP) and the Morro Bay Volunteer Monitoring Program (VMP) (1993-2004) indicate that dissolved oxygen is periodically exceeding the numeric water quality standards at two of the four stations in Los Osos Creek and Warden Creek.

To further characterize the impairments in the creek and identify potential causes, data analyses were conducted to examine relationships between nutrient levels, algal growth, and dissolved oxygen in conjunction with the *Los Osos Creek, Warden Creek, and Warden Lake Wetland Nutrient TMDL.*

The conclusions that can be drawn from available data include:

- Dissolved oxygen water quality objectives (WQOs) are exceeded in the lower portions of the Los Osos Creek and Warden Creek. Because dissolved oxygen concentrations do not achieve numeric water quality objectives in these reaches, the 303(d) listings cannot be removed.
- Dissolved oxygen levels support WQOs at two stations (LVR and TUR) in Los Osos and Warden Creeks. As such, the reaches upstream of these monitoring sites are not

considered as impaired for dissolved oxygen. These segments of the waterbodies can be removed from the 303(d) list.

- Multiple factors (not all measured) may be contributing to depressed oxygen levels, including stream canopy, temperature, algal growth, flow, tidal influences including backwater and decreased stream velocities, in the lower creek; however, data coverage is insufficient to derive an explicit linkage between variables.

Based on the review of available information the TMDL approach is as follows:

1. Because low dissolved oxygen levels on the lower reaches of Los Osos and Warden Creeks are expected to be primarily influenced by tidal effects including backwater and decreased stream velocities, and other environmental conditions, implementing actions upstream (e.g. nutrient control measures) will not likely generate a corresponding improvement in dissolved oxygen levels. As such, a TMDL will not be developed for dissolved oxygen in Los Osos and Warden Creeks at this time.

2. Because the upstream reaches of Los Osos and Warden Creeks are attaining WQOs for dissolved oxygen, these waterbody segments can be removed from the 303(d) list.

3. A systematic program will be designed and implemented to further assess the relationships between flow, velocity, sunlight, nutrients, algal growth and dissolved oxygen in conjunction with the *Los Osos Creek, Warden Creek, and Warden Lake Wetland Nutrient TMDL.*

4. If warranted, a subsequent TMDL will be developed to address dissolved oxygen impairments. If justified, staff will recommend delisting Los Osos Creek and Warden Creek for dissolved oxygen.

1.3. Watershed Description

Los Osos Creek is located in San Luis Obispo County on the central coast of California. The watershed is in a Mediterranean climate, with warm dry summers and cool wet winters. The geology of the watershed is a mix of igneous, metamorphic and sedimentary rock less than 200 million years old. Average temperature is about 12°C (54°F). Average annual rainfall ranges from 45 cm (18 inches) at the coast to 89 cm (35 inches) on the ridge; most of this rainfall occurs between November and April (sources: Department of Water Resources, 1958; Ernstrom, 1984).

Los Osos Creek has two main branches and drains to the Morro Bay estuary (Figure 1). The Warden Creek branch of Los Osos Creek drains to the east through Los Osos Valley and includes a specifically designated wetland area in its' middle reach, Warden Lake Wetland. The Los Osos Creek branch drains to the south through Clark Canyon.

Land use in the Warden Creek watershed is primarily rangeland and cropland and land use in the Los Osos Creek watershed is dominated by woodland with areas of rangeland and urban. Table 1 summarizes the land use in the Los Osos and Warden Creek watersheds.

Table 1. Land use categories within the Los Osos Creek watershed (acres/% total)

	Brushland	Woodland	Rangeland	Cropland	Urban	Total
Warden Creek	-	161	5,260	2,911	-	8,332
	0%	2%	63%	35%	0%	100%
Los Osos Creek	278	3,164	1,753	522	962	6,679
	4%	47%	26%	8%	14%	100%

Source: based on UC Santa Barbara GAP data and CDF Wildlife Habitat Relationships, 1998.

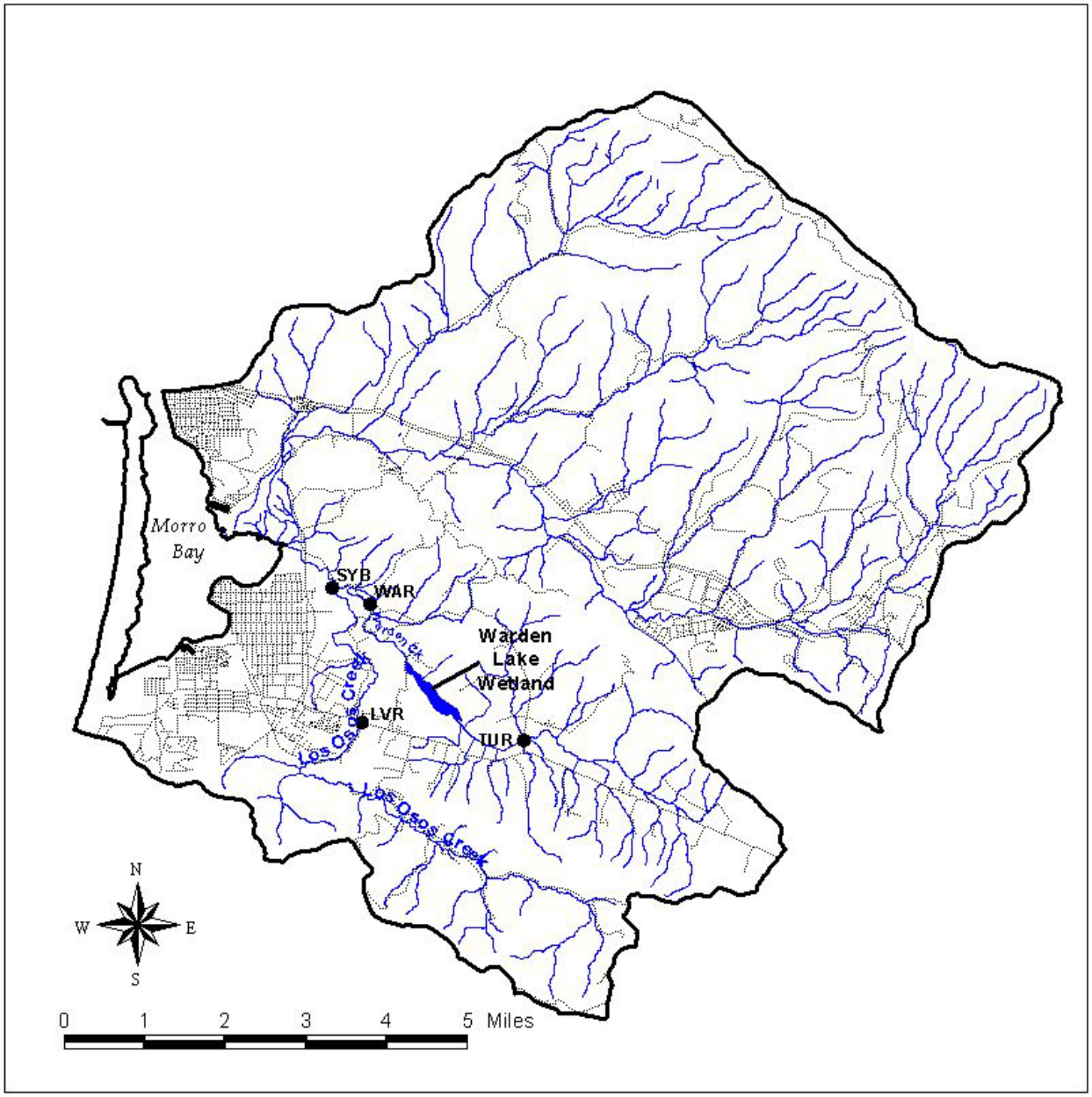

Figure 1. Waterbodies and monitoring sites within the Los Osos Creek watershed.

2. WATER QUALITY STANDARDS

Regional Water Quality Control Boards (Regional Boards) define beneficial uses for waterbodies in their Water Quality Control Plans (Basin Plans). Also included in the Basin Plan are numeric and narrative objectives to be protective of the beneficial uses designated for each waterbody. The following sections discuss the applicable beneficial uses and water quality objectives related to the 303(d) listing for dissolved oxygen in Los Osos Creek.

2.1. Beneficial Uses

Los Osos Creek and Warden Lake Wetland have designated beneficial uses in the Basin Plan. Warden Creek is not specifically listed in the Basin Plan. Table 2 summarizes the designated beneficial uses for Los Osos Creek and Warden Lake Wetland and shows beneficial uses interpreted to apply to Warden Creek. The Basin Plan states that surface waterbodies within the region that do not have beneficial uses designated for them, such as Warden Creek, are assigned the beneficial uses of "municipal and domestic water supply" and "protection of both recreation and aquatic life." Staff interpreted this general statement of beneficial uses to encompass the four Beneficial Uses shown in Table 2 for Warden Creek.

Table 2. Beneficial uses for Los Osos Creek, Warden Creek, and Warden Lake Wetland.

Waterbody	Los Osos Creek	Warden Creek[1]	Warden Lake Wetland[2]
Municipal and Domestic Supply (MUN).	X	X	
Agricultural Supply (AGR)	X		X
Industrial Process Supply (PROC)			
Industrial Service Supply (IND)			
Ground Water Recharge (GWR)	X		X
Water Contact Recreation (REC-1)	X	X	X
Non-Contact Water Recreation (REC-2)	X	X	X
Wildlife Habitat (WILD)	X		X
Cold Fresh Water Habitat (COLD)	X		
Warm Fresh Water Habitat (WARM)	X	X	X
Migration of Aquatic Organisms (MIGR)	X		
Spawning, Reproduction, and/or Early Development (SPWN)	X		X
Preservation of Biological Habitats of Special Significance (BIOL)			
Rare, Threatened, or Endangered Species (RARE)	X		X
Estuarine Habitat (EST)			
Freshwater Replenishment (FRSH)	X		
Navigation (NAV)			
Hydropower Generation (POW)			
Commercial and Sport Fishing (COMM)	X		X
Aquaculture (AQUA)			

Inland Saline Water Habitat (SAL)			
Shellfish Harvesting (SHELL)			

[1] Warden Creek is not specifically listed in the Basin Plan; therefore, two general uses (encompassing four Beneficial Uses) designated for all waterbodies in the Region apply to Warden Creek: Municipal and Domestic Water Supply (MUN) and protection of both recreation and aquatic life (REC-1 REC-2, WARM).

[2] The beneficial uses designated for the Warden Lake Wetland apply only to the middle reach of Warden Creek

2.2. Water Quality Objectives

Water quality objectives applicable to the 303(d) listing include the following:

- numeric objectives for the specifically designated beneficial uses in Los Osos Creek and Warden Lake Wetland;
- the general numeric objective for dissolved oxygen applicable to Warden Creek

Numeric objectives for dissolved oxygen are listed in Table 3.

Table 3. Water quality objectives for dissolved oxygen and nitrate

Beneficial Use	Dissolved Oxygen Objective
General	median values should not fall below 85 percent saturation as a result of controllable water quality conditions.
AGR	Minimum of 2 mg/L
COLD	Minimum of 7 mg/L
WARM	Minimum of 5 mg/L
SPWN	Minimum of 7 mg/L

3. DATA REVIEW

This section summarizes the dissolved oxygen data collected as part of the Morro Bay National Monitoring Program (NMP) and the Volunteer Monitoring Program (VMP). Figure 1 shows the locations of monitoring stations on Los Osos Creek (LVR and SYB) and Warden Creek (TUR and WAR). No data were available from the Warden Lake Wetland. This report describes dissolved oxygen conditions only; additional data analyses related to nutrients and algal growth are included in the *Los Osos Creek, Warden Creek, and Warden Lake Wetland Nutrient TMDL.*

3.1. Dissolved Oxygen

Table 4 summarizes available dissolved oxygen data and Figures 2 and 3 show the observed dissolved oxygen at stations on Los Osos Creek and Warden Creek, respectively. Table 5 summarizes available percent saturation data on Los Osos Creek and Warden Creek. Dissolved oxygen and percent saturation levels at the downstream station in Los Osos Creek (SYB) and

Warden Creek (WAR) fell below the applicable water quality objectives throughout the period of record. (Because monitoring was discontinued at WAR in 2000, recent dissolved oxygen data are not available at this station.) Dissolved oxygen at LVR on Los Osos Creek and TUR on Warden Creek consistently met water quality objectives, with the exception of 1 sample collected at TUR in 2002. Therefore, staff does not consider these reaches (LVR and TUR) to be impaired for dissolved oxygen.

Low dissolved oxygen (along with algal growths) may be impacted by nutrient loading to the streams, but is expected to be primarily influenced by tidal effects such as backwater and decreased stream velocities, canopy and shading, temperature, and other environmental conditions. Sufficient and consistent data are not available to evaluate the direct causes. In particular, the available data on algal extent and frequency are qualitative and cannot be used to correlate with potential sources or causes.

Table 4. Summary of Dissolved Oxygen Data in Los Osos Creek and Warden Creek

Station	Start Date	End Date	No. of Samples	Min. (mg/L)	Avg. (mg/L)	Max. (mg/L)	Applicable WQO	No. Below WQO	% Below WQO
LVR	1/11/94	2/26/04	113	7.3	9.28	12.32	>7 mg/L	0	0%
SYB	11/21/95	4/14/04	181	2.72	7.90	15.88	>7 mg/L	55	30%
TUR	12/14/93	4/8/04	249	1.57	9.17	17.4	>5 mg/L	1	0%
WAR	12/14/93	9/12/00	199	0.69	6.16	16.68	>5 mg/L	43	22%

Table 5. Summary of Percent Saturation Data in Los Osos Creek and Warden Creek

Station	Start Date	End Date	No. of Samples	Min. (%)	Median (%)	Max. (%)	Applicable WQO (%)	Within WQO
LVR	1/11/94	2/26/04	113	70	94	116	≥85	Y
SYB	11/21/95	4/14/04	178	36	76	199	≥85	N
TUR	12/14/93	4/8/04	248	18	91	189	≥85	Y
WAR	12/14/93	9/12/00	198	7	64	161	≥85	N

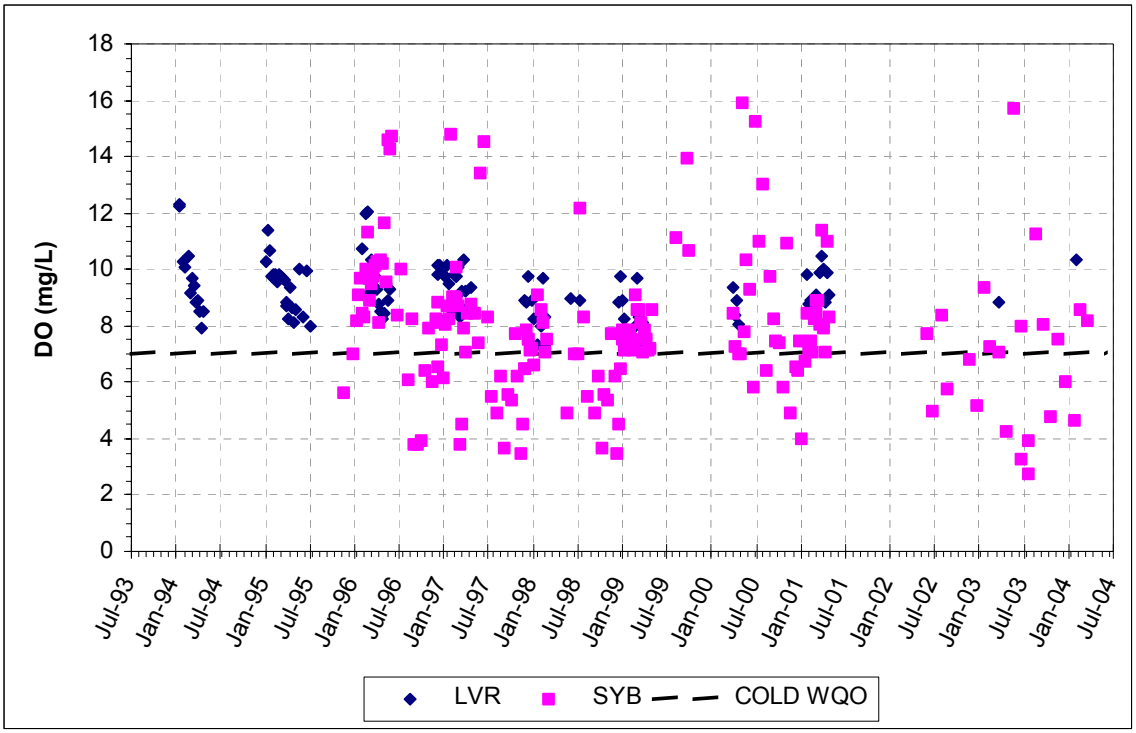

Figure 2. Dissolved oxygen levels at LVR and SYB on Los Osos Creek

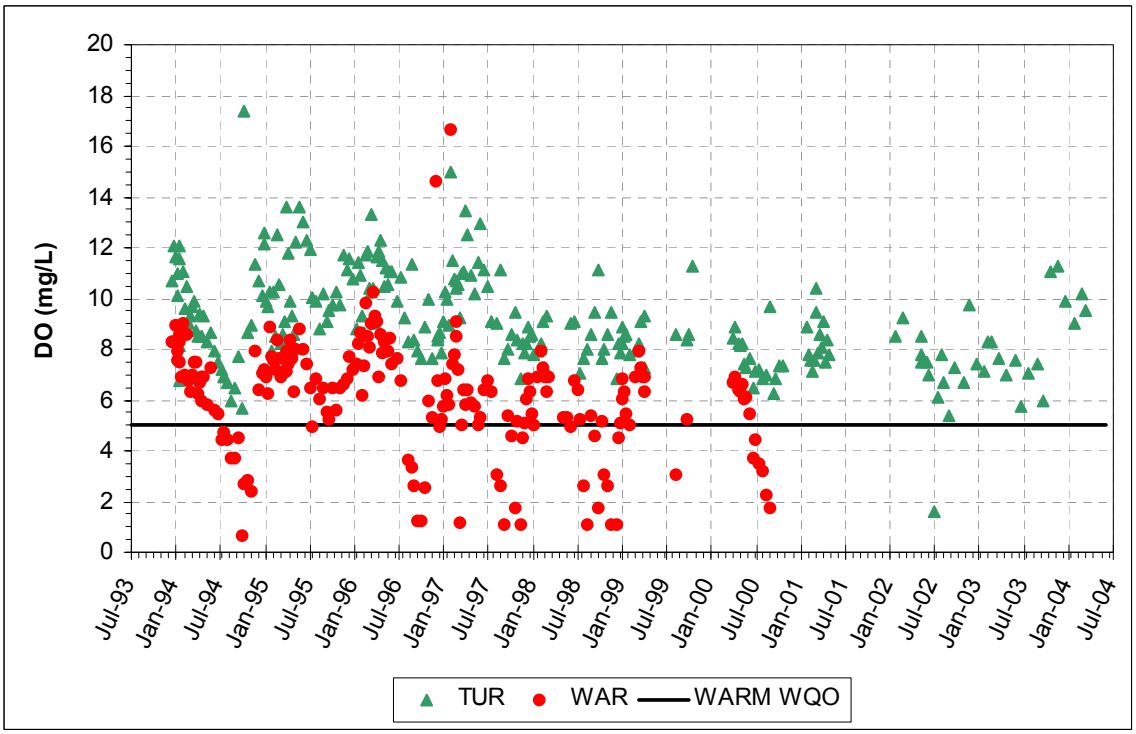

Figure 3. Dissolved oxygen levels at TUR and WAR on Warden Creek

3.2. Data Summary

Dissolved oxygen levels support WQOs at two stations (LVR and TUR) in Los Osos and Warden Creeks. As such, the reaches upstream of these monitoring sites are not considered as impaired for dissolved oxygen. Therefore, these segments of the waterbody can be removed from the 303(d) list.

Dissolved oxygen levels do not meet WQOs at the two other stations (SYB and WAR) in the lower reaches of Los Osos and Warden Creeks. Low dissolved oxygen may be impacted by nutrient loading to these reaches of Los Osos and Warden Creeks, but is expected to be primarily influenced by tidal influences including backwater and decreased stream velocities, canopy and shading, temperature, and other environmental conditions. However, sufficient and consistent data are not available to evaluate the direct causes. A TMDL is not being proposed for dissolved oxygen in Los Osos and Warden Creeks at this time. Rather, a systematic program to further assess the relationships between flow, velocity, sunlight, nutrients, algal growth and dissolved oxygen will be designed and implemented in conjunction with the *Los Osos Creek, Warden Creek, and Warden Lake Wetland Nutrient TMDL*. TMDLs to address algal growth and dissolved oxygen in Los Osos Creek and Warden Creek will be written, if necessary, when the additional data are collected.

4. MONITORING

The Regional Board will conduct further monitoring in conjunction with the *Los Osos Creek, Warden Creek, and Warden Lake Wetland Nutrient TMDL* to investigate and obtain information to determine causes of algal blooms and dissolved oxygen conditions that may be causing impairments (flow, dissolved oxygen, temperature, total nitrogen, total phosphorous, nitrate, phosphate, algal biomass, chlorophyll, benthics). The additional monitoring in the lower reaches of the Warden Creek and Los Osos Creek watersheds will provide information to confirm and further characterize potential impairments by low dissolved oxygen.

Staff will pursue re-instating monitoring further downstream on Warden Creek at or near WAR and an additional monitoring site (LOC) on the downstream reaches of Los Osos Creek. The additional sites will provide better spatial coverage and help to provide a comprehensive assessment of the progress toward attainment of water quality objectives throughout the watersheds. The sites may be modified for adequate assessment to gain cooperation from agencies, organizations and landowners.

In addition, Regional Board staff are involved in a state-wide effort to establish protocols for determining causes of algal blooms and dissolved oxygen conditions that may be causing impairments, and proposing control options, where reduction of nutrient loading alone is unlikely to generate a response in the waterbody.

Staff will implement the monitoring plan and review the continuing and expanded monitoring results every three years in conjunction with the *Los Osos Creek, Warden Creek, and Warden*

Lake Wetland Nutrient TMDL. If warranted, Regional Board staff will present to the Regional Board for approval a dissolved oxygen TMDL (problem statement, numeric targets, implementation plan, etc.) to address low dissolved oxygen levels. However, if protection of beneficial uses is demonstrated (i.e., the data do not show exceedances of dissolved oxygen objectives) then Regional Board staff will propose de-listing of the waterbody for dissolved oxygen impairments.

5. IMPLEMENTATION

A TMDL and associated implementation plan is not being proposed for dissolved oxygen in Los Osos and Warden Creeks at this time. Rather, a systematic monitoring program *(as discussed above in Section 4 – Monitoring)* will be designed and implemented in conjunction with the *Los Osos Creek, Warden Creek, and Warden Lake Wetland Nutrient TMDL*. TMDLs to address low dissolved oxygen levels in the lower reaches of Los Osos Creek and Warden Creek will be written, if necessary, when the additional data are available. If dissolved oxygen objectives are being met, Regional Board staff will recommend the waterbody be removed from the 303(d) list.

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